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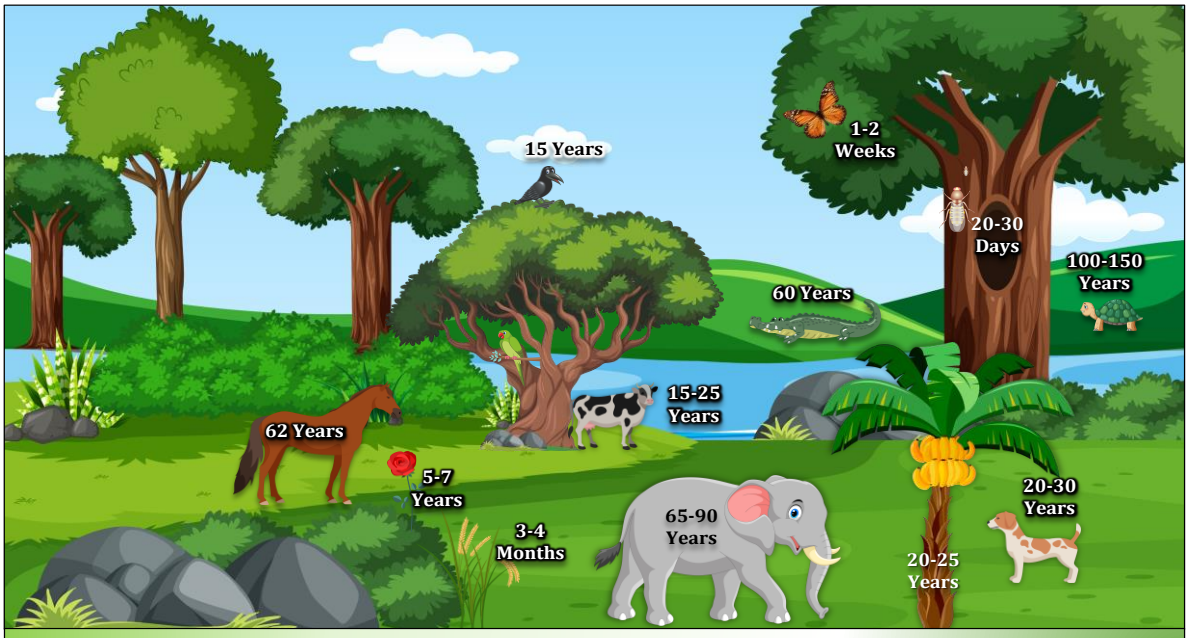
01 Reproduction in Organisms

1. Life Span :

- Each and every organism can live only for a certain period of time.
- It may be as short as a few days or as long as a few thousand years.
- The life spans of organisms are not necessarily correlated with their sizes.
- The period from birth to the natural death of an organism represents its **life span**.
- Life spans of organisms are not necessarily correlated with their sizes for ***e.g.*** the sizes of crows and parrots are not very different yet their life spans show a wide difference.
- Similarly, a mango tree has a much shorter life span as compared to a peepal tree. Whatever be the life span, death of every individual organism is a certainty, i.e., no individual is immortal, except single-celled organisms.



Approximate life spans of some organisms

Reproduction :

- Reproduction is defined as a biological process in which an organism gives rise to young ones (offspring) similar to itself. The offspring grow, mature and in turn produce **new offspring**. Thus, there is a cycle of birth, growth and death.
- Reproduction enables the **continuity of the species**, generation after generation.
- The organism's habitat, its internal physiology and several other factors are collectively responsible for how it reproduces.

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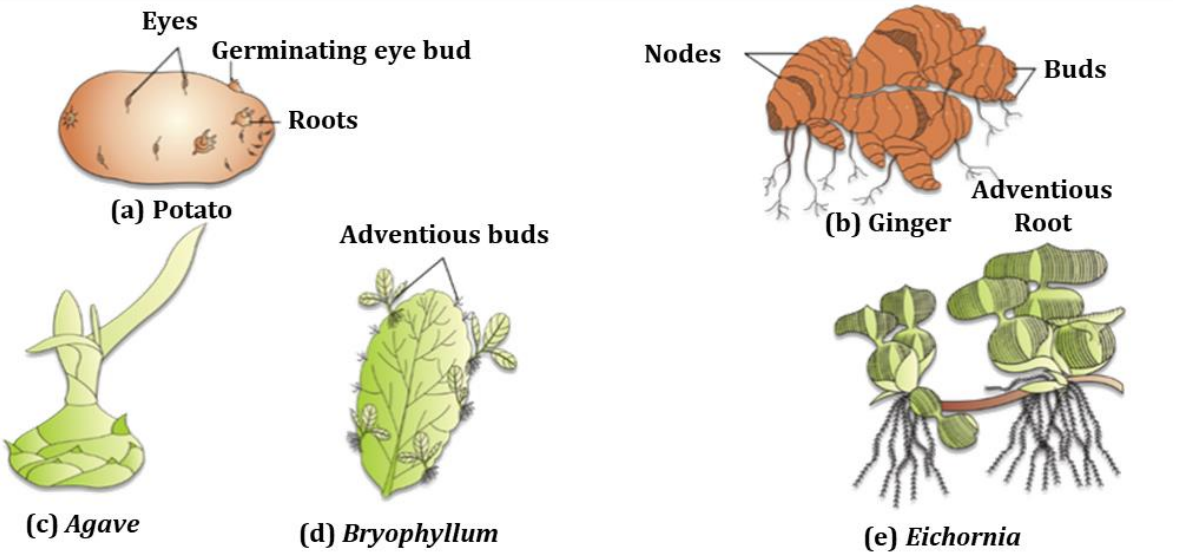
- When offspring is produced by a single parent with or **without the involvement of gamete formation**, the reproduction is asexual. When two parents (opposite sex) participate in the reproductive process and also involve fusion of male and female gametes, it is called **sexual reproduction**.

2. Asexual reproduction :

- In this method, a single individual (parent) is capable of producing offspring. As a result, the offspring that are produced are not only identical to one another but are also exact copies of their parent.
- Are these offspring likely to be genetically identical or different? Answer will be **genetically identical**.
- The term **clone** is used to **morphologically and genetically similar individuals**
- Many single-celled organisms (monerans and protists) reproduce by **binary fission**.
- Member of kingdom fungi and algae reproduce through special asexual reproductive structures called zoospores.
- Conidia (Penicillium) buds (Hydra) and gemmules (sponge) are other common asexual reproductive structures.

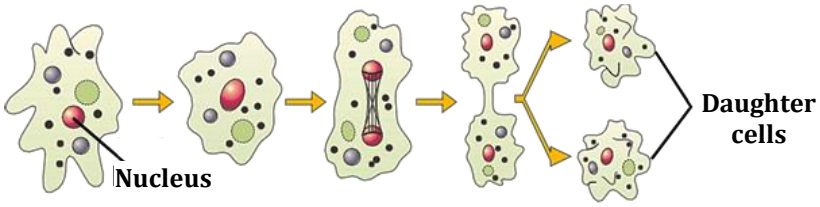


Vegetative propagules in angiosperms : (a) Eyes of potato; (b) Rhizome of ginger; (c) Bulbil of *Agave*; (d) Leaf buds of *Bryophyllum*; (e) Offset of water hyacinth (*Eichhornia*)

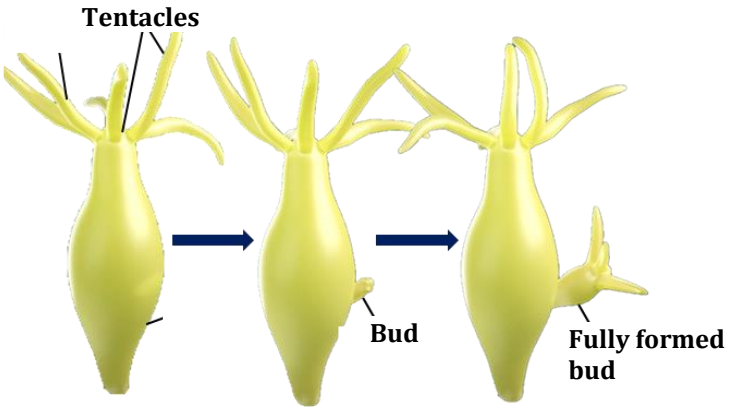
- The fleshy bud which produces new plants in hydrophytes is called **Turion**
- Is vegetative reproduction also a type of asexual reproduction? Answer **will be yes**.
- Is the term clone applicable to the offspring formed by vegetative reproduction? Answer **will be yes**.
- While in animals and other simple organisms the term asexual is used **unambiguously**, in plants, the term vegetative reproduction is frequently used.
- In plants, the units of vegetative propagation such as **runner, rhizome, sucker, tuber, offset, bulb** are all capable of giving rise to new offspring. These structures are called **vegetative propagules**.
- **'Water hyacinth'** (Terror of Bengal) which is one of the most invasive weeds found growing wherever there is **standing water**. It drains oxygen from the water, which leads to death of fishes.
- This plant was introduced in India because of its **beautiful flowers** and **shape of leaves**. Since it can propagate vegetatively at a phenomenal rate and spread all over the water body in a short period of time, it is very difficult to get rid of them.

Types: -

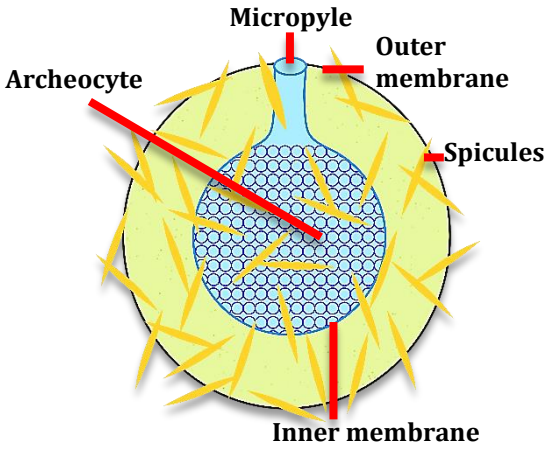
(i) Binary Fission: **e.g.**: *Amoeba*, *Paramecium*



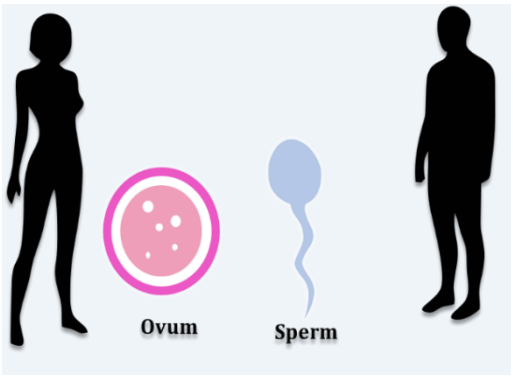
(ii) Budding *e.g.* *Hydra*



(iii) Gemmule *e.g.* Sponge



3. Sexual Reproduction :



- Sexual reproduction involves formation of the male and female gametes, either by the same individual or by different individuals of the opposite sex. These gametes fuse to form the zygote which develops to form the new organism. It is an **elaborate, complex** and **slow process** as **compared to asexual reproduction**.
- Because of the fusion of male and female gametes, sexual reproduction results in offspring that are not identical to the parents or amongst themselves.
- Plants, animals or fungi differ greatly in external morphology, internal structure and physiology, when it comes to sexual mode of reproduction, surprisingly, they share a similar pattern in sexual reproduction.

Different phases of life in sexual reproducing organisms:

(a) Juvenile Phase:

- All organisms have to reach a certain stage of growth maturity in their life, before they can reproduce sexually.
- In animals, this period of growth is called the **Juvenile phase**, while in plants it is known as **vegetative phase**.
- Juvenile phase is of variable durations in different organisms.
- In some plants, where flowering occurs more than once, what would you call the inter-flowering period – juvenile or mature? Answer will be **mature**.
- **Plants–the annual and biennial types, show clear cut vegetative, reproductive and senescent phases**, but in the **perennial species it is very difficult to clearly define these phases**.

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- A few plants exhibit unusual flowering phenomenon; some of them such as bamboo species flower only once in their life time, **generally after 50-100 years**, produce large number of fruits and die.
- Another plant, ***Strobilanthus kunthiana*** **(neelakuranji)**, flowers **once in 12 years**. As many of you would know, this plant flowered during September-October 2006. Its mass flowering transformed large tracks of hilly areas in **Kerala, Karnataka** and **Tamil Nadu** into blue stretches and attracted a large number of tourists.

(b) Reproductive Phase:

- The end of juvenile phase is marked by the beginning of the next phase called reproductive phase.
- In animals, the juvenile phase is followed by morphological and physiological changes prior to active reproductive behaviour.
- In several animals, including human beings, the reproductive maturity is marked by a number of changes that occur in their bodies.
- The reproductive phase is also of variable duration in different organisms.
- **During reproductive phase**, the females of placental mammals exhibit cyclical changes in the activities of ovaries and accessory ducts as well as secretion of hormones.
- In non-primate mammals like cows, sheeps, rats, deers, dogs, tigers, etc. such cyclical changes during reproduction are called **Oestrus cycle** where as in primates (monkeys, apes and humans) it is called **menstrual cycle**.
- Many mammals are reproductively active throughout their reproductive phase and hence are called **continuous breeders**.
- The end of **reproductive phase can be considered** as one of the **parameters of senescence or old age**.
- There are concomitant changes in the body (like slowing of metabolism, etc.) during this last phase of life span. old age ultimately leads to death.
- In both plants and animals, **hormones are responsible for the transitions between the three phases**. Interaction between hormones and certain environmental factors regulate the reproductive processes and the associated behavioural expressions of organisms

Breeding Seasons: -

- In most of animals do not breed throughout the year, instead they are **seasonal breeders**.
- For instance; birds living in nature lays eggs only seasonally.
- However, birds in captivity (as in poultry farms) can be made to lay eggs throughout the years by hormonal treatment. In this case, egg laying is not related to reproduction but is a commercial exploitation for human welfare.

(c) Senescence (Aging) Phase :

After reproductive maturity all organisms enter into a senescent phase. Senescence may be defined as the period between reproductive maturity and death of the organism.

In both plants and animals, hormones are responsible for the transitions between the three phases.

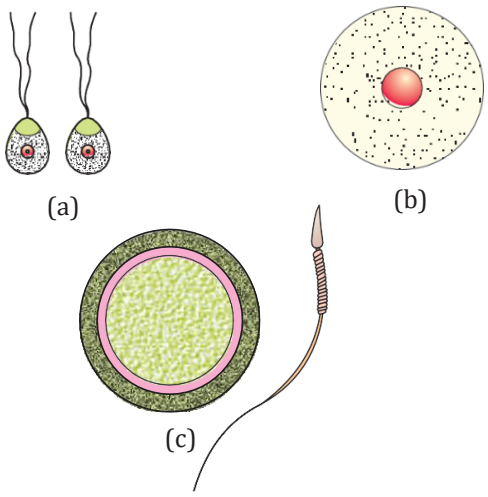
Interaction between hormones and certain environmental factors regulate the reproductive processes and the associated behavioural expressions of organisms.

4. Events in Sexual Reproduction :-

- After attainment of maturity, all sexually reproducing organisms exhibit events and processes that have remarkable fundamental similarity, even though the structures associated with sexual reproduction are indeed very different.
- The events of sexual reproduction though elaborate and complex, follow a regular sequence.

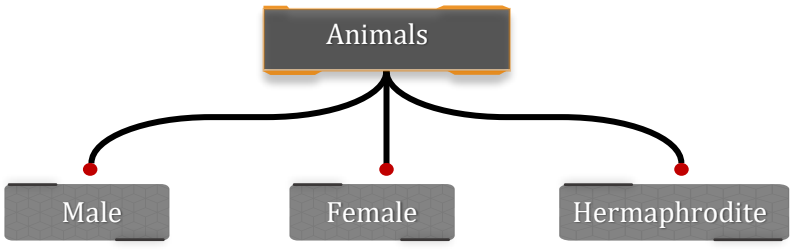
(A) Gametogenesis :-

- In some algae the two gametes are so similar in appearance that it is not possible to categorise them into male and female gametes.
- The process of formation of the two types of gametes- male and female.
- Gametes are haploid cells.
- **Homogametes or isogametes: -** In some algae, the two gametes are so similar in appearance that it is not possible to categorise them into male and female gametes, called homogamgetes or isogametes.
- **Heterogametes: -** In a majority of sexually reproducing organisms the gametes produced are of two morphologically distinct types. In majority of animal species, the individuals are either male or female such animals are called **unisexual**.
  e.g. : **Human,** Monkey, **Cockroach** etc.



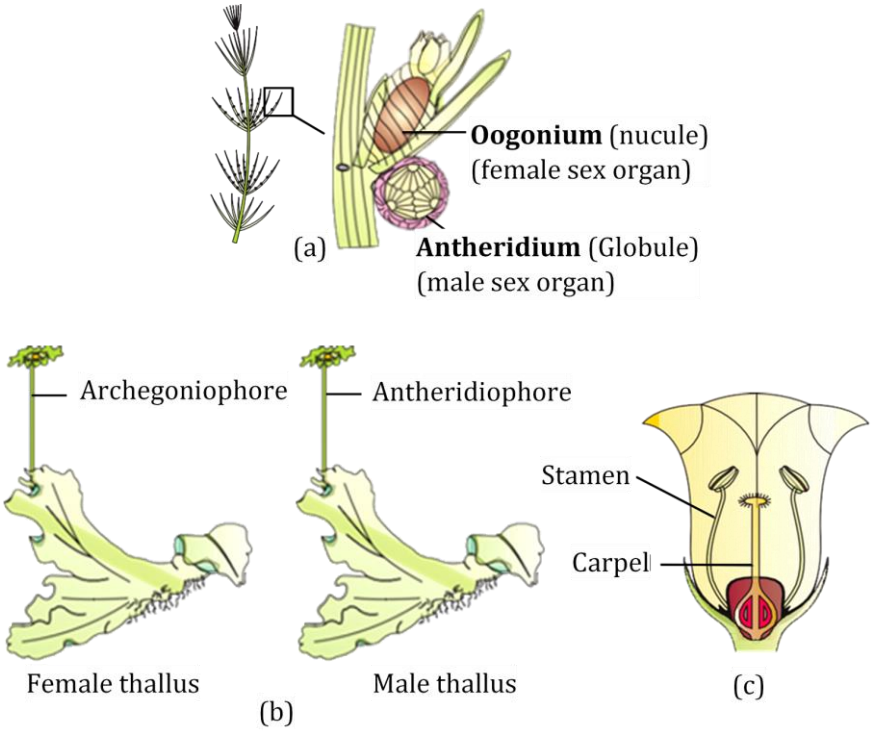
Types of gametes: (a) Isogametes of *Cladophora* (an alga); (b) Heterogametes of *Fucus* (an alga); (c) Heterogametes of *Homo sapiens* (Human beings)

- Some animal species possess both male and female reproductive organs such animals are termed ***bisexual*** or ***hermaphrodites***.
  e.g. : **Sponges, tapeworm, earthworm, leech.**
- In diploid organisms, specialised cells called **meiocytes** (gamete mother cells) undergo meiosis and form gamete.
- Sexual reproduction in organisms generally involves the fusion of gametes from two different individuals. But **this is not always true.**
- In several fungi and plants, terms such as **homothallic** and **monoecious** are used to denote the **bisexual condition** and **heterothallic** and **dioecious** are the terms used to describe **unisexual condition.**
- In flowering plants, the unisexual **male flower is staminate,** i.e., bearing stamens, while the **female is pistillate** or bearing pistils.
- In some flowering plants, both male and female flowers may be present on the same individual **(monoecious)** or on separate individuals **(dioecious).**
- Some examples of **monoecious plants** are **cucurbits** and **coconuts** and of **dioecious plants** are **papaya** and **date palm.**



Cell Division during gamete formation :-

- In all heterogametic species gametes are of two types- Male and Female
- A haploid parent produces gametes by mitotic division.
- Several organisms belonging to Monera, fungi, algae and bryophytes have **haploid** plant body, but in organisms belonging to pteridophytes, gymnosperms, angiosperms and most of the animals including human beings, the parental body is **diploid**.



Diversity of sexuality in organisms : (a) Monoecious plant (*Chara*); (b) Dioecious plant (*Marchantia*); (c) Bisexual flower (sweet potato)

Table : Chromosome Numbers in Meiocytes (diploid, 2n) and Gametes (haploid, n) of Some Organisms.

Name of organisation	Chromosome number in melocyte (2n)	Chromosome number in gamete (in)
Human beings	46	23
House fly	12*	6
Rat	42	21
Dog	78	39
Cat	38	19
Fruit fly	8*	4
Ophioglossum (a fern)	1260	630
Apple	34	17
Rice	24	12
Maize	20	10
Potato	48	24
Butterfly	380*	190
Onion	16	8

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(B) Gamete transfer :

- After their formation, male and female gametes must be physically brought together to facilitate their fusion (fertilisation).
- In a **majority of organisms, male gamete is motile** and the **female gamete is stationary**.
- In **angiosperms** and in **red algae** both male and female gametes are non-motile.
- In several simple plants like **algae, bryophytes** and **pteridophytes**, water is the medium through which this gamete transfer takes place. A large number of the male gametes, however, fail to reach the female gametes. To compensate this loss of male gametes during transport, the number of male gametes produced is several thousand times the number of female gametes.
- In **bisexual, self-fertilising plants**, ***e.g.***, peas, transfer of pollen grains to the stigma is relatively easy as anthers and stigma are **located close to each other**; pollen **grains soon after they are shed, come in contact with the stigma**. But in cross pollinating plants (including **dioecious plants**), a specialised event called pollination facilitates transfer of pollen grains to the stigma. Pollen grains germinate on the stigma and the pollen tubes carrying the male gametes reach the ovule and discharge male gametes near the egg.
  In dioecious animals, since male and female gametes are formed in different individuals, the organism must evolve a special mechanism for gamete transfer. Successful transfer and coming together of gametes is essential for the most critical event in sexual reproduction, the fertilisation.

(C) Fertilisation :-

- The most vital event of sexual reproduction is perhaps the fusion of gametes. This process called **syngamy** results in the formation of a **diploid zygote**. The term fertilisation is also often used for this process. The terms **syngamy** and **fertilisation** are frequently used though, **interchangeably**.
- Where does syngamy occur? In most aquatic organisms, such as a majority of algae and fishes as well as amphibians, syngamy occurs in the external medium (water), i.e., outside the body of the organism. This type of gametic fusion is called **external fertilisation**.
- In many terrestrial organisms, belonging to fungi, higher animals such as reptiles, birds, mammals and in a majority of plants **(bryophytes, pteridophytes, gymnosperms and angiosperms)**, syngamy occurs inside the body of the organism, hence the process is called **internal fertilisation. In all these organisms, egg is formed inside the female body where they fuse with the male gamete**.
- In organisms (e.g. bryophytes and pteriodphytes) exhibiting internal fertilisation, the male gamete is motile and has to reach the egg in order to fuse with it. In these even though the number of sperms produced is very large, there is a significant reduction in the number of eggs produced.
- **In seed plants, however, the non-motile male gametes are carried to non-motile female gamete by pollen tubes**.
- The female gamete undergoes development to form new organism without fertilisation this phenomenon is called parthenogenesis.

(D) Post Fertilisation Events :-

Events in sexual reproduction after the formation of zygote are caused post fertilization events.

(i) The Zygote: -

- Formation of the diploid **zygote is universal** in all **sexually reproducing organisms**. In organisms with external fertilisation, zygote is formed in the external medium (usually water), whereas in those exhibiting internal fertilisation, zygote is formed inside the body of the organism.
- **In organisms belonging to fungi and algae, zygote develops a thick wall that is resistant to desiccation and damage. It undergoes a period of rest before germination**.
- Zygote is the vital link that ensures continuity of species between organisms of one generation and the next.

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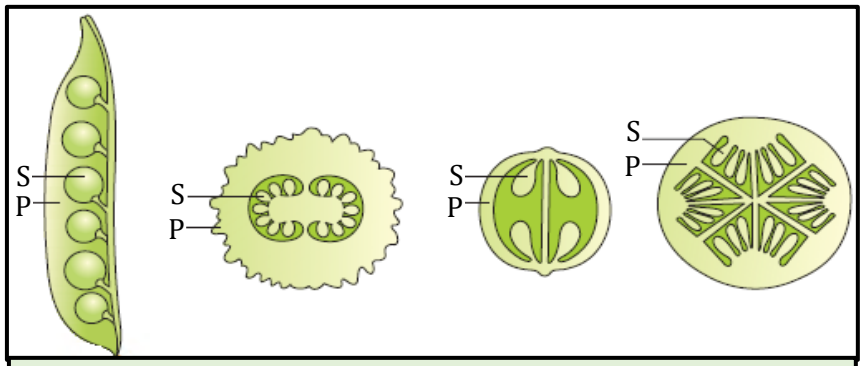
(ii) Embryogenesis

- **Embryogenesis refers to the process of development of embryo from the zygote.** During embryogenesis, zygote undergoes **cell division** (mitosis) and **cell differentiation.** While cell divisions increase the number of cells in the developing embryo; cell differentiation helps groups of cells to undergo certain modifications to form specialised tissues and organs to form an organism.
- Animals are categorised into oviparous and viviparous based on whether the development of the zygote takes place outside the body of the female parent or inside, i.e. whether they lay fertilised/unfertilised eggs or give birth to young ones.
- In *oviparous animals* like reptiles and birds the fertilised eggs covered by hard calcareous shell are laid in a safe place in the environment; after a period of incubation young ones hatch out. On other hand, in *viviparous animals* (Majority of mammals including human beings), the zygote develops into a young one inside the body of the female organism. Because of proper embryonic care and protection, the chances of survival of young ones is greater in viviparous organisms.
- In flowering plants, **the zygote is formed inside** the ovule. After fertilisation the sepals, petals and stamens of the flower wither and fall off. The **pistil however, remain attached to the plant.** The zygote develops into the embryo and the ovules develop into the seed. **The ovary develops into the fruit** which develops a protective and thick wall called pericarp.



A few kinds of fruit showing seeds (S) and protective pericarp (P)

BEGINNER'S BOX-1 INTRODUCTION

1. Which of the following is not used for vegetative propagation?
(1) Bud (2) Bulbil (3) Tuber (4) Antherozoids

2. The "Eyes" of the potato tuber are :-
(1) Root buds (2) Flower buds (3) Shoot buds (4) Axillary buds

3. Gametes are generally :-
(1) Haploid (2) Triploid (3) Diploid (4) Hexaploid

4. Sexual reproduction is characterized by :-
(1) Two parents participation (2) Formation of gametes
(3) Fusion of gametes (4) All of these

5. Pre-fertilization events among these are: -
(1) Syngamy (2) Gametogenesis and gamete transfer
(3) Formation of zygote (4) Embryogenesis

6. Transfer of pollen grains from anther to stigma is known as: -
(1) Emasculation (2) Pollination (3) Bagging (4) Fertilization

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7. Oestrus cycle are found in :-
(1) All cordates (2) All non-cordates (3) All primates (4) Non-Primates

8. Which type of gametes are found in *Fucus* (alga)?
(1) Isogametes (2) Heterogametes
(3) Homogametes (4) Both (1) and (3)

9. In haploid parents gametes are produced by:-
(1) Meiotic division (2) Mitotic and then meiotic division
(3) Meiotic and then mitotic division (4) Mitotic division

10. Select the incorrect statement :-
(1) In majority of organism male gamete motile & female gamete is non-motile/stationary.
(2) In angiosperm & brown-algae, both male & female gametes are non-motile.
(3) In algae, Bryophyta and Pteridophyta, water is the medium through which gamete transfer takes place.
(4) Pollination facilitates transfer of pollen grains to the stigma.

11. Read the following statements about "Terror of Bengal" and select the correct ones?
(i) "Terror of Bengal" is the name given to water hyacinth, an algae.
(ii) Eichhornia was introduced in India due to its aesthetic value.
(iii) Eichhornia drains oxygen from the water which leads to death of fishes.
(1) (i) and (ii) (2) (i) and (iii) (3) (ii) and (iii) (4) (i), (ii) and (iii)

12. Identify the incorrect pair?
(1) Fungi - zoospores (2) Algae - gemmules
(3) Conidia - *Penicillium* (4) Buds - *Hydra*

13. If the offspering are produced by asexual reproduction, then the resultant offspring will be: -
(1) Genetically similar but morphologically distinct
(2) Genetically differ but morphologically similar
(3) Both genetically and morphologically similar
(4) Both genetically and morphologically distinct

14. Vegetative propagation in *Pistia* occurs by:-
(1) Stolon (2) Offset (3) Runner (4) Sucker

15. The offspring produced by asexual reproduction are termed as?
(1) Filial generation (2) Clone (3) Bud (4) Rhizome

BEGINNER'S BOX — ANSWERS KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	4	4	1	4	2	2	4	2	4	2
	Que.	11	12	13	14	15					
	Ans.	3	2	3	2	2					

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ESSENCE

- **Life span :** The period from birth to death is known as life span
- Life span of organisms are not necessarily correlated with size of organisms
- There is no natural death in unicellular organisms
- **Reproduction :** A biological process occurs only in living organisms.

Reproduction

Asexual reproduction	**Sexual reproduction**
• Uniparental	• Biparental (usually)
• Fusion of gametes absent	• Fusion of gametes occurs
• Offsprings are genetically identical	• Offsprings show variations

Sexual Reproduction

Zoospores | Conidia | Bud formation | Gemmule

- **Vegetative Reproduction :** In plants, asexual reproduction is commonly called vegetative reproduction.

Vegetative Reproduction

Runner | Rhizome | Sucker | Tuber | Offest | Bulb

Sexual Reproduction (Events)

Pre fertilization
- Gametogenesis
  - Isogametes (Homogametes) *Cladophora*
  - Heterogametes *Fucus*
- Gamete transfer

Fertilization
- External
- Internal

Post Fertilization
- Embryogenesis

- External fertilization occurs in algae, fishes and amphibians
- Internal fertilization occurs in few algae and from bryophytes to angiosperms

- **Bisexual Animals :** Earthworm, leech, sponge, tapeworm etc.
- **Unisexual animals :** Cockroach, human etc.
- **Monoecious plants :** Chara, *cucurbita*, coconut etc.
- **Dioecious plants :** *Marchantia*, papaya, date palm etc.
- Plant body is haploid in Monera, fungi, algae and bryophytes.
- Plant body is diploid in gymnosperms, angiosperms and most of the animals.
- In sweet potato flowers are bisexual